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THE CLASSIFICATION OF STRATIFIED ROCKS.

THE problem opened for discussion in the "Symposium on Classification, etc," in the May–June number of the JOURNAL OF GEOLOGY is much wider than the compass of the particular questions raised. It was by no means lack of interest in this problem, or in the particular questions, that led the writer to refrain from participation in the symposium. My opinion, then as now, was that the real difficulties in the case will not be solved by reaching even uniform replies to the questions; and further, the meeting which was held in September, of the International Commission on Stratigraphic Classification, which I then expected to attend, was another reason for delay in expressing an opinion till after the meeting of the commission.

Taking up the subject, where it was opened in the "Symposium," I will attempt first to give a reply to the preliminary question, raised in the introduction by the following sentence, viz.:

"Granting that these questions cannot be answered finally at present, or in the near future, it is still urgent to inquire: *By the use of what system, provisionally adopted for current use, can we best work on toward better systems in the future?*"<sup>1</sup> In framing a reply to this question, let me first call your attention to the steps already taken toward the construction of a provisional system of general classification and nomenclature for stratified rocks.

It will be remembered that in 1878, twenty years ago, the

<sup>1</sup>JOUR. GEOL. Vol. VI, p. 334.

first International Congress of Geologists met in Paris. The chief purpose of this congress, as set forth in the first article of its programme was, "*Le'unification des travaux géologique au point de vue de la nomenclature et du figure*," which in English is — the attainment of uniformity in the naming, classifying and mapping of geological facts. At Paris papers were read and discussions were held, but few results were reached beyond the appointment of commissions to prepare for definite future work. At the second meeting, held in Bologna in 1881, a commission was appointed with power delegated to take the necessary steps for the making of a geological map of Europe. The discussions at this congress and at the next, held in Berlin in the year 1885, and the work of the commissions meeting at Foix in 1882, at Zurich in 1883, at Geneva in 1886 and at Manchester in 1887, all were directed toward the perfecting of a system of nomenclature, classification and cartography upon which to construct this European map. The map necessarily covered the territory of a number of independent states, whose geological surveys had been carried on independently by men speaking in several different tongues, and it was necessary to reach uniformity in nomenclature and method of representation of the facts for all these European states, in order to construct that map. Although the map was not then complete, at the time of meeting of the London Congress in 1888, the great majority of the disputed questions had been settled. In many cases the agreements were rather compromises, necessitated for the execution of a common map, than real settlement of the disputed points, or the attainment of actual uniformity in usage.

Thus the European classification and nomenclature, as set forth in the decisions of the congresses previous, it may be said, to St. Petersburg, were incident to the preparations of a geological map of Europe, and should not be regarded as constituting a universal scheme, any more than that devised for the preparation of a geological map for a similarly restricted area in another continent. Some American geologists realized this fact and, while taking deep interest in the discussions and the

expression of the views of their fellow workers, saw no reason for interference with, or the taking of an active part in, the solution of questions which pertained so largely to European geology. It was evident, to one watching the work of the congress, that the difficulties and dissent increased as the territory under consideration enlarged. England and Russia whose domains lay farthest from the center of Europe had greater difficulty in adjusting their classifications and nomenclatures to the common scheme than did the diverse states situated in the central part of Europe; and the geologists of the United States, most of all, have found insurmountable difficulties to the complete application of the European scheme to their own work. After the questions relative to the construction of the geological map of Europe were settled, this general dissatisfaction with attempts to settle questions of science by majorities resulted, at the London meeting, in the decision no longer to settle questions of general debate by formal votes; and in the following congresses, at Washington, Zurich and St. Petersburg, only such questions as had been submitted for consideration to commissions, and were carefully formulated, were put to formal vote of the body of the congress.

While these things were going on in the congress, the geologists of the United States were active along the same lines in their own country.

A few American geologists attended the Berlin Congress in 1885, and prepared a detailed English report of the proceedings. (The official proceedings of the congresses have been reported in French.) After their return an American committee, composed of fifteen geologists, set to work to prepare a report on the classification and nomenclature then in use in America. This report was submitted at, and published as a part of the proceedings of, the London Congress in 1888. In this report, the state of progress toward uniformity in the United States, of both nomenclature and classification of stratified rocks was given in summary form; and some of the difficulties and diversities in usage were pointed out. Following this, and probably suggested by one of

the chapters of the report, a Division on Correlation, as a distinct department of the survey, was organized by the Director of the United States Geological Survey. A series of bulletins were published (Nos. 80-86), in which a thorough discussion was made of the historical development of knowledge, nomenclature, and classification of each of the grand systems of the geological column on the American continent. The first "essay" was published at the time of the Washington Congress, in 1891. Two of the volumes contemplated have not been published at the present date. Each of them was prepared by a specialist and was based upon thorough study of literature and knowledge of the facts.

In this series of essays, the fact was clearly demonstrated, (which had been already announced for the Devonian in the American committee's report) that the formations of each one of the grand geological systems present such great diversity in physical features and even in the particular composition of their faunas, that two, three, and, in some cases, four distinct classifications, with as many sets of different names are needed to represent the true state of facts regarding each one as known to science at the present time, in the United States alone.

The first of this series of bulletins on correlation was issued in 1891, at the time of the meeting of the International Congress of Geologists at Washington.

While the European geologists were struggling with the various difficulties arising in the attempt to put the geological features of the various states of Europe onto a single map, with a single system of color conventions and a common legend, the United States Geological Survey was dealing with similar problems on the continent of North America. Not only was the territory covered by the work of the United States Geological Survey quite as vast as that covered by the map of Europe (the total area of Europe being 3,800,000, and that of the United States being 3,536,290), but the geology in the several states in America is found to present a greater variety of expression and more complete diversity of composition than is expressed in the states

of Europe altogether. So that the members of the United States Geological Survey, in their own legitimate work, have been obliged to consider as wide problems as have engaged the International Congress of Geologists, whose preponderating majority is made up of European members.

As early as 1881 a cartographic system was devised by the survey for the preparation of its maps. This was described in the second annual report of the survey and also was communicated to the Second International Congress meeting at Bologna in 1881. As happened to similar schemes presented by representatives of the various Europeans, this was a provisional scheme whose modification was the natural result of their comparison at the meetings of the congress, and the trials of the system in actual mapping of widely diverse problems.

In the years 1889-90 the importance of a uniform and established scheme for all the maps of the United States led to the holding of a "Conference on Map Publication," which was called by the Director of the Survey, was composed of nineteen of the most experienced and ablest geologists of the country, and was held in Washington, in January 1889,

As a result of this conference a scheme of classification and set of rules for use in mapping the results of the work of the United States Geological Survey were prepared. These rules were published in the Tenth Annual Report in 1889, and have been the basis upon which the reports and maps of the survey have been constructed since then. The scheme differs from the European scheme adopted by the International Congress in many particulars. The difference which is most striking on comparing the two, has relation to the principle of uniformity itself. The European system is built on the assumption that uniformity in nomenclature is practicable, and should be attained as far as consistent with the divergent opinions and practices of the various states concerned. The United States system is fundamentally elastic, and rests on the general assumption that uniformity is practicable only in respect to the grander divisions, and that diversity in both naming and classifying the subdivisions of

the geological systems is both practicable and necessary to the true representation of the facts in the case.

It is this fundamental characteristic of the United States scheme which furnishes the answer to the question quoted at the beginning of this article from the "Symposium" of a few months ago. The system which should be adopted provisionally for current use, both by geological workers and by teachers, must recognize this fundamental fact, that the units which it is attempted to name and classify in stratigraphical geology, are not constant units, presenting uniform characters for the whole world or for each continent, but are very inconstant, preserving the same characters for only very limited areas.

Since this is known to be the actual fact regarding geological formation, it is useless to attempt to hold to a rigid system of nomenclature, or to raise the vain hope that the use of the same names will help us over the difficulties arising from the great diversity of facts.

Having recently attended the meeting of the International "*Commission des classifications stratigraphiques*" in Berlin, it is with great pleasure that I am able to report that the commission appointed at the St. Petersburg Congress adopts this principle of elasticity in all matters of detail as a foundation principle in the construction of rules for use in discussing international stratigraphy. Professor Renevier, the chairman of the commission, has not yet published his official report of the proceedings, hence I will not attempt the discussion of details until the report is received. But I believe it will interest all American geologists to know, that several principles, which we believe in, and on account of which has arisen some of our dissatisfaction with the European nomenclature and classification adopted by the International Congress for the map of Europe, will be recommended as the basis of an international system of classification.

One of these points is the recognition that the so-called systems, or units of the second order, are the smallest divisions of the geological scale to which uniform names and position in the classification can be given in an international scheme.

A second point is that, even in the definition of these systems, a degree of elasticity must be left for the geologists of different continents and countries.

A third point is the adoption of a set of prefixes (*Paleo*, *Meso* and *Neo*) to be attached to the name of the system as a method of reaching comparative uniformity in the naming of divisions of the third order.

The fourth point is the leaving to the local geologist, the task of selecting local geographic names for the divisions of the fourth order.

Other points were discussed, but these are sufficient to show the trend of the discussions.

When the report of the commission is published, a fuller presentation of the matter will naturally occur, but until then it seems to the writer that any attempt to make a more rigid classification or nomenclature for general purposes is not to be desired.

What we all are striving for is a scheme of nomenclature and classification by which we can clearly express and represent the grander conclusions of our science which are at present so much hidden by the multitude of details. But it is necessary to bear in mind, while seeking to attain this end, that refinement or uniformity in classification, or in methods of representing the facts, will not discover the principles coördinating and determining the relations of these facts to each other. The system of our classification must be based upon the knowledge already possessed, and so long as we have not discovered the clue to the great diversity presented by stratigraphic units, we must retain all the diversity they express in our detailed descriptions of them, and wait for uniformity in respect to the lesser matters until we discover the principles upon which the diverse phenomena are bound together into a systematic whole.

It must be realized that many of these diversities, in name and relations to each other of the facts of geology, which confuse the student as his studies extend to details of the geology of other areas and other countries, are not due to different usage,



language, or understanding, but to actual diversity in the facts themselves, which only wide and profound studies in comparative historical geology can reduce to a system. When, therefore, we attempt to speak of geological events in their chronological relations, the known truth can be expressed only by an elastic use of a universal scale whose divisions are few, and whose boundaries are not precise.

HENRY SHALER WILLIAMS

NEW HAVEN, CONN.

October 28, 1898.